# **Technical specification for cold storage and**

# **brine freezer to be installed in M. Mulah**

Refrigeration system design solution description

# **Basis of the refrigeration system scheme**

## 1. Outdoor design parameters

1. Project Location: Maldives
2. Outdoor design parameters
   1. Calculated temperature outside ventilation: +32.2 °C;
   2. Calculated daily average temperature outside the air conditioning room: +30.5 °C;
   3. The average 50-hour wet bulb temperature per year outdoors is not guaranteed: +28.1°C;
   4. Calculated relative humidity outdoors: 80%;

(5) Condensation temperature: 35 °C; **2,** **2, construction scale:**

The project site is located in the Maldives and a new brine freezer is required. A total of 5 brine freezer tanks,

each tank should freeze 10 tons of Tuna of varying sizes, the central temperature of the fish is required to be reduced to -10 °C within 8 hours, a total of 50 tons, twice a day, and the evaporator form is a spiral tube heat exchanger. Or bundle type, In addition, a 500-ton cold storage warehouse needs to be configured, which is divided into two 250-ton refrigerated rooms.

## The construction scale of this project is as follows:

**Cold room technical requirements and parameter table**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| serial number | Cold room name | Floor area m2 | Net height  （m） | Theoretical calculation of nominal tonnage (T). | quantity | Into the pool | Temperature of the pool (°C). | Outlet temperature  （℃） | Cooldown time  （h） | Pool temperature  （℃） |
| 1 | Brine freezer |  |  | 10T | 1 | 10T | +25 | -16 | 8 | -20 |
| 2 | refrigerator |  | 6 | 50T | 1 | 10% | -14 | -22 | 16 | -30 |

**\*hold 500 tons at -18oC~-22oC**

Note (1): The above table is a drawing parameter, as the basis for the calculation of the refrigeration scheme, if the parameters change, the scheme needs to be changed accordingly.

(2) The value of the heat flow per unit of the enclosure structure: 10W/m2, which is required to meet this value for the owner building and the insulation structure.

(3) Evaporator capacity shall be calculated to 30% extra than requires to compensate high landing time extra loading, as it will be hard to fill each tank exactly 10 tons

(4) Cold store shall be designed in a way to cool down 50 tons of Tuna of incoming daily load from temp bringing down from -14oC to -20oC withing 16 hrs time, in addition to hold 500 tons at -18oC~-22oC.

## 3. Design basis

* 1. "Cold Storage Design Code" GB50072-2021
  2. "HVAC Design Code" GB50019-2012

(3) Industrial Metal Pipe Design Code GB50316-2000 (2008 Edition).

1. "General Principles of Insulation Technology for Equipment and Pipes" GB/T4272-2008
2. "Equipment and Pipe Insulation Design Guidelines" GB/T8175-2008
3. "Pressure Pipeline Safety Technical Supervision Regulation Industrial Pipelines" TSG D0001-2009
4. "Pressure Pipeline Specification Industrial Pipeline" GB/T 20801-2006
5. "Specification for the Construction and Acceptance of Installation works of ammonia refrigeration systems" SBJ 12-2011
6. "Specification for the Construction and Acceptance of Installation Projects of Refrigeration Equipment and Air Separation Equipment" GB 50274-2010
7. "Industrial Equipment and Pipeline Thermal Insulation Engineering Construction Quality Acceptance Specification" GB50185-2010
8. Field Devices Industrial pipe welding engineering construction code GB 50236-2011
9. "General Specification for Construction and Acceptance of Mechanical Equipment Installation Project" GB 50231-2009
10. Other applicable national and local norms, regulations and standards
11. Technical parameters, building plans and related information provided by the owner

In line with the technical level of advanced, mature, economical and practical, simple operation, reliable operation, energy saving principles, the formulation of this program. This solution includes: refrigeration systems.

# **Refrigeration system design scheme**

**1, refrigeration system division**: abide by the safety, energy saving, economy, simple operation of the principle of division system.

**2. Refrigeration working fluid:** ammonia (R717); **refrigeration oil:** special oil for **ammonia making agent**.

**3. Liquid supply mode:** pump liquid supply.

**4. Control mode:** automatic/manual liquid supply.

**5, melting method:** hand command automatic water flushing

## 6. System division:

**(1)** **, quick freezing room** **+** **refrigeration room system:** refrigerant: NH3

Evaporation/condensation temperature: -25°C/+35°C Liquid supply type: Pump liquid

## 7. Cold room design load

**According to the owner's requirements, determine the system design load**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| serial number | Room name | Room temperature °C | Number of rooms | Single room device negative  Lotus (kw). | Total mechanical load  （KW） | Evaporation temperature °C |
| 1 | Brine freezer | -20 | 5 | 1380 | 1200 | R717/-40 |
| 5 | refrigerator | -25 | 1 | 82 |

**8. Selection of compressor and low-pressure equipment**

**7. Selection of compressor and low-pressure equipment**

**(1)** **Cooling host:**

**(1)** **500** **tons of cold storage** **+ 50T** **brine freezer system:** **1200kw**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | Working conditions (Te/Tc) °C | Cooling capacity kW | Shaft power kW | Motor power kW | Number of units |
| MYCOM/SABROE/GRASSO or Equivalent | -25℃/+35 | 653.84 | 266.78 | 280 | 3 |

### (2) Low-pressure circulating liquid storage tank and ammonia pump:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| name | Low-pressure circulation barrel | | Ammonia pump | | |
| Quantity × model | Single parameter | quantity | Single parameter | remark |
| Brine freezer | 1× 2 | Volume 10m³ | 3 units | Flow rate 11.2m³/h, head 32m | Dual-use, one-piece |
| 500T cold storage | Or 2× | Volume 10m³ | 3 units | Flow rate 6m³/h, head 32m | One with one |

**(3) End heat exchange equipment:**

The evaporator of the brine freezer is a spiral tube heat exchanger.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cold room name | Number of rooms | Single room area㎡ | Evaporation temperature °C | Single room equipment load kw | The number of units × |
| Brine freezer | 1 | / | -25 | 1380 | 1×5（Q=276kw） |
| 500T cold storage | 1 | 360 | -25 | 130KW | 1×2（50KW) |

### 8. Selection of other auxiliary equipment:

1. **condenser:**

The condensation temperature is +35°C, and the average outdoor temperature of 50 hours per year is not guaranteed: +28.1°C, and the heat dissipation coefficient is 0.71. 500T+ brine freezer refrigeration system selects 3 sets of evaporative condenser produced independently, with a total heat discharge of 3000KW,to Meet system requirements. The temperature in the Maldives is high all year round, it is recommended to enlarge it by about 1.2 times to choose, it is recommended to use 3 sets of evaporation cooling, evaporation cooling 2 sets.

(3) 3. End heat exchange equipment:

Refrigerated air cooler in the warehouse, the evaporator is made of ceiling type stainless steel tube aluminum sheet air cooler, evaporation temperature -35 °C, the heat exchange of each fan is 50KW, the heat exchange area is 350 m2, air volume 44000m3/h, wind pressure 290pa, range 28m. Two 250-ton warehouses are divided into 1 unit, a total of 2 units.

Brine freezer, the evaporator in the form of spiral tubular evaporator plus agitator. When the evaporation temperature is -25 °C, each freezer is used in two groups, each heat exchanger is 150KW, and the two groups are 300KW for a total of 10 groups, exchange heat 1500KW

(4) The oil cooler adopts a siphon:

equivalent siphon, the thermal siphon refrigeration cycle is most suitable for areas with poor water quality or systems using evaporative condensers. Its characteristics: the unit is small in size, the oil cooling is reliable, and the oil temperature after cooling is generally more than condensation

The temperature is 10°C-20°C. Compared with the water-cooled type, there is no need for cooling water, and the waterway system is simplified

There is no problem of heat exchange tube fouling affecting the heat exchanger heat exchanger, which can improve the cooling efficiency;

There is also no effect on compressor exhaust and power consumption. At the same time, it also has the effect of assisting the reservoir.

### (5) Reservoir:

The system design horizontal liquid reservoir two for the storage of ammonia in the system.

### (6) Oil collector:

1 oil collector produced in-house is selected to meet the requirements of use.

### (7) Automatic air separator:

1 air separator produced in-house is selected to meet the requirements of use.

### (8) Emergency ammonia leaker:

1 set of emergency ammonia dischargers produced in-house is selected to meet the requirements of use.

**10. System Description:**

1. All valves, instruments, and automatic control components of the ammonia refrigeration system are to be made of ammonia-specific products.
2. Safety valves are to be provided on the reservoir, evaporative condenser, oil collector, and screw compressor unit oil separator. A liquid reservoir and oil collector are to be set up to display the level gauge on-site.
3. The ammonia system pipes are all to be made of 20# seamless steel pipes for transporting fluids (GB/T8163-2008), and the pipe diameter steel pipes not larger than φ20 are all made of 304 stainless steel seamless pipes. φ38 and above system pipes are based on argon arc welding and arc welding cover. (All diameters are estimations)
4. The ammonia system low-temperature equipment and tube bundle insulation adopts polyurethane on-site foam insulation, and single tube insulation adopts rigid polyurethane thermal insulation pipe tiles. The external protective layer of the insulation of the machine room equipment is to be selected from a 0.6mm thick aluminum plate, and the outer protective layer of pipeline insulation is to be selected from a 0.8mm thick aluminum plate.
5. The ammonia system pipe to adopt the suspended ceiling pipe frame structure. From the roof of the machine, the house reserved a lifting point downwards to lead out the pipe boom, cross-bearing. Between the low-temperature insulation pipe and the support and hanger, between the low-temperature container and the foundation, a mat soaked in asphalt is to be added to prevent the formation of a cold bridge. The evaporative condenser is located on the roof of the chiller house.
6. Refrigeration system pipes and equipment to be coated with anti-rust primers and topcoats. Insulation pipes and equipment to be adjected on the outer protective layer（All insulation covers out side machine are shall be sus 316, inside machine room can use sus 304)

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Goal awareness. The color mark of the paint is in accordance with the provisions of the Cold Storage Design Code.

**11. System security:**

1. Device security

The compressor unit must have perfect protection alarm measures such as oil pump motor overload, main motor overload, exhaust pressure ultra-high, low oil pressure, large suction pressure difference, ultra-high oil temperature, and unmoved spool valve the liquid pump must-have protection such as small pressure difference, ultra-high filter resistance, motor overload, and automatic bypass of overpressure.

1. NH3 Leak Detection Alarm Exhaust System ≦

The upper part of the refrigeration room must be provided with an ammonia leakage alarm device, which has the function of alarming the concentration is too high. The explosion-proof accident exhaust fan in the machine room must be linked with the working medium leakage alarm to open the ventilation when the working fluid leaks.

1. NH3 venting

An emergency ammonia discharge tank needs to be set up near the machine room for the discharge of all the ammonia in the machine room in an emergency. (this steel tank uses drain gases from the system, or just discharges all gases there, in case of emergency and re-claim back to the system, if so tank must have way cool down to the easy transfer of gases)

12. Other matters

1. During civil construction, the craftsman should pay close attention to the location of the pipeline through the wall, the hole through the floor slab and the position of the buried hanging point or the buried bolt for reinforcing the pipeline, etc., and if it is found that there is a discrepancy, it should be corrected in time. In order to better strengthen the pipeline, if there is an inappropriate place found in the construction, the reinforcement point can be added or changed as appropriate, and the anchor bolt position of the machine and equipment foundation must be checked with the actual object before it can be buried.

1. In the construction and installation process of the refrigeration system, the industry standard "Ammonia Refrigeration System Installation Engineering Construction and Acceptance Specification" should be strictly observed
2. Other outstanding matters shall comply with the current normative requirements of the country.

Appendix (1): Refrigeration pipe insulation layer thickness table

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ℃  Pipe diameter | D273 | D219 | D159 | D133 | D108 | D89 | D76 | D57 | D45 | D38 | D32 | ≦D25 |
| -28 | 110 | 100 | 90 | 90 | 90 | 80 | 80 | 70 | 70 | 70 | 60 | 60 |
| -8 | 90 | 90 | 80 | 80 | 80 | 80 | 70 | 70 | 70 | 60 | 60 | 50 |

Appendix II: Refrigeration equipment insulation layer thickness table

|  |  |  |  |
| --- | --- | --- | --- |
| serial number | name | Model | Insulation thickness |
| 1 | Horizontal barrel pump unit |  | 160MM |
| 2 | Drain bucket |  | 100MM |

Schedule III: List of major refrigeration equipment

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| serial number | Device name | Specifications and models | unit | quantity | remark |
| 1 | Screw compressors | Cooling capacity: 980.76KW Motor power: 420KW | platform | 3 | Cooling capacity: 980.76KW Motor power: 420KW Smaller compound screw compressor shall be added to maintain the plant in low landing time to reduce energy consumption  Compressors shall be well-known brands such as  MYCOM/SABROE/GRASSO. |
| 2 | The horizontal barrel pump unit | Flow rate: 11.2m3/h, one-for-one use | platform | 1 | Flow rate: 11.2m3/h, one-for-one use |
| 3 | Evaporative condenser | Heat exchange: 3750kw, motor power 5 \* 16KW | platform | 5 | Heat exchange: 3750kw, motor power 5 \* 16KWCondenser must have 750KWx 5 units  Or installed 500 KW 8 units, 7 in duty one in stand by  Tubes and fins must be made of material that resists corrosion as the plant is installed near the sea  And it is natural the plant will be drawn sea water mist to condensers. (Match) |
| 4 | Siphon |  | platform | 1 |  |
| 5 | High-pressure reservoir |  | platform | 2 |  |
| 6 | Stainless steel tube aluminum sheet air cooler | Cooling capacity: 50KW heat transfer area: 350m2, cold storage | platform | 2 | Cooling capacity: 50KW heat transfer area: 350m2, cold storage |
| 7 | Spiral tube heat exchanger | Cooling capacity: 150KW/unit, heat exchange area: 75m2/unit | platform | 10 | Cooling capacity approximately 150KW/unit, heat exchange area: 75m2/unit |
| 8 | Oil concentrator |  | platform | 1 |  |
| 9 | Emergency ammonia drain |  | platform | 1 |  |
| 10 | Air separator |  | platform | 1 |  |

**Installation instructions for ammonia systems**

First, the installation of machinery and equipment

This description is one of the design documents, is the technical requirements of the refrigeration process design for the installation project, the engineering installation should be built according to the construction drawings, this description has the same effect.

1. The installation requirements of ammonia compressors and units (including commissioning and acceptance requirements) shall comply with the relevant provisions and requirements in the "Specifications for the Construction and Acceptance of Installation Projects of Refrigeration Equipment and Air Separation Equipment" (GB50274-2010).
2. (2) After the installation of the unit, the empty car should be operated for 6H, the empty car should be operated for 24H after the load operation is qualified, and the lubricating oil and cleaning piston should be replaced after the load operation.
3. System piping installation
4. The pipe is made of steel pipe (seamless steel pipe), the quality of the pipe must be checked one by one before installation, impurities and oxide scale must be removed, and the inside of the pipe must be very clean. Clean pipes must be plugged with corks at both ends and must not be stored in the open. The inner wall of the seamless steel pipe should not be galvanized.
5. The seamless steel pipes are welded by argon arc welding primer and electric welding cover.
6. The ammonia system pipeline should have a slope, the exhaust pipe should have a 1 to 2% % aspect oil separator, and the suction pipe should be sloped from the evaporator to the compressor, and there should be a slope of not less than 2%%%.
7. For the finished stamping elbow with a curvature radius R=3.5D for seamless steel pipes, the on-site pipe bending production and its quality requirements should comply with the relevant provisions of the current national standard "Industrial Metal Pipeline Engineering Construction and Acceptance Specifications" GB50235.
8. valve
9. Ammonia system with a variety of valves (such as shut-off valves, throttle valves, solenoid valves, etc.), must use ammonia special products, all valves should be clear flow direction installation.

(2) The solenoid valve should be energized before installation to verify whether it is sensitive and reliable, and the power supply voltage should be consistent with the nameplate.

(3) Globe valves, check valves, solenoid valves and other valves should check whether the valve seal line is damaged, and the valve with packing must check whether the packing can be sealed well, and if necessary, it must be replaced. The valve is used after descaling and anti-rust treatment.

(4) Before the installation of the safety valve, the lead seal and the factory certificate should be checked, and if the specified pressure does not match the design, the valve should be unsealed and adjusted according to the regulations.

(5) After the valve is cleaned, the valve should be opened and closed 4 to 5 times, and then the valve should be closed and the leak test should be tested with nitrogen (or injected with kerosene, and it will not leak for two hours to be qualified);

(6) In the process of transportation, storage and placement, the valve should be blocked at both ends (except for the takeover end), should be placed in a ventilated and dry place, not allowed to be stored in the open air, and not allowed dirt, water, etc. to enter the valve, causing the valve to scale and rust again.

(7) The valve must be installed straight.

Fourth, the system discharge, pressure test, leak detection

(1) System sewage: After the system is installed, 600KPa (gauge pressure) nitrogen is used for segmented sewage blowing, and then the whole system is blown, and the sewage discharge shall not be less than 3 times. And use white paper to test at the sewage outlet until the gas is discharged without water vapor, oil pollution, rust, and other debris.

(2) After the system is discharged, the air tightness and air pressure test should be carried out, and the test pressure should be shown in the pressure characteristic table. Bottled high-pressure nitrogen must be perfused with a decompression table.

(3) When testing pressure, in addition to the suction and exhaust valves of the compressor, the globe valve in front of the safety valve and the valve connecting to the atmosphere, all the valves on the pipeline are opened, and the refrigeration installation of the whole system is completed through the fluorine valve, and after the load trial operation is qualified, the inspection is carried out according to the relevant regulations and the formal acceptance procedures are handled. Unified inflation. When the system reaches the specified pressure, check each weld, flange, and valve with soap liquid and carefully observe whether there is leakage. Where the leakage is large, there is a small sound, and a large foam appears, and where the leakage is small, there is a small foam intermittently, so the leak detection must be careful and repeatedly checked 3 to 5 times. The leak should be marked, repaired after the pressure is removed, and then tested until the leak is eliminated. Then the system is maintained for 24 ~ 48h, if the pressure is not reduced, the test pressure is qualified.

(4) After the system discharge and pressure test are completed, all valve spools should be cleaned.

Fifth, the vacuum test

(1) After passing the air tightness test, the vacuum test is carried out, the purpose of the vacuum test is to further check the air tightness of the system and eliminate air and other non-condensable gases, and to evaporate the water in the system.

(2) The vacuum test uses a vacuum pump for systematic evacuation.

(3) The system is pumped with a vacuum pump to a residual pressure of less than 5.333KPa (40mmHg) and runs continuously for 10 to 24h to evaporate the water of the system. And keep the remaining pressure in the system 5.333KPa placed for 24h, the system boost should not exceed 0.667KPa (5mmHg), such as the reason for the recovery, is the system not strict, or due to the evaporation of water in the system, water vapor Caused by the rise in the sub-pressure, if the system is not strict, the air tightness test should be redone.

Sixth, the insulation of equipment and pipelines

(1) After the above pressure test and vacuum test are qualified, before perfusion of Freon, the equipment and pipelines working under evaporation pressure should be covered with an insulation layer located in a room at room temperature.

(2) The construction of the insulation layer should be strictly in accordance with the requirements, the insulation layer must be dense and firm with the equipment and pipelines, and there must be no gaps.

(3) Equipment and pipes working under condensation pressure are not insulated.

(4) The pipe insulation layer is made of polyurethane insulation.

Seven, filled with ammonia refrigerant

(1) Before the ammonia system is filled with ammonia, it is necessary to repeatedly check the safety of the equipment, the opening of the valve, and it is best to have the safety department personnel confirm the safety of the situation on the spot to carry out ammonia filling.

(2) Ammonia filling requires 2-3 professional production personnel to cooperate with each other, be familiar with the knowledge of ammonia, know the tight handling method of ammonia, and wear safety clothing for ammonia filling.

(3) The amount of ammonia filled should be in accordance with the design requirements and should not exceed 70% of the reservoir.

8. Trial operation

After the system is filled with ammonia, it can be transferred to trial operation, and the purpose of the trial operation is to check whether the system is normal and whether the amount of ammonia charged is appropriate. If the ammonia is charged too much, it will make the suction, exhaust (7) valve must be installed straight. The pressure is too high, the machine is easy to punch the cylinder, then the excess ammonia should be extracted, such as insufficient ammonia filling, will produce suction, exhaust pressure is low, the return air is overheated, the library temperature can not be reduced and other phenomena, then should be supplemented with ammonia, until the operation is normal.